EXTENDING THE GROWING SEASON AND YEAR-ROUND PRODUCTION OF SHIITAKE ON NATURAL LOGS

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A primary disadvantage of growing shiitake outdoors in most climates is the limitation of seasonal harvests, meaning you'll be limited to marketing to seasonal outlets.

Ideally, you will want to extend the season as long as possible, and this can be accomplished through use of protective coverings and strain management. The following is a hypothetical management plan for extending the growing season.

For example, assume you inoculated 1500 logs about one year ago, with 60% of the logs inoculated with wide-range strains, 20% inoculated with cold weather strains, and the remaining 20% with warm weather strains. These percentages were chosen to maximize mushroom quality during the various seasons. These percentages may change with location and with what season you prefer to produce the most mushrooms.

Presume you will force 100 logs per week, yielding .25 to .5 pounds of mushrooms per flush per log, for a harvest of about 30 pounds per week.

SPRING

Early spring temperatures are cool, so the logs you would logically fruit would be those inoculated with cold weather strains. Since spring weather can be anything but predictable, equip yourself with burlap, plastic and fruiting blankets. Cold periods in the spring, fall and winter in the South produce mushrooms very slowly and you may go through 10 days of very cool weather where the mushrooms seem to stop growing. You should use any or a combination of coverings to protect your potential crop from wind, rain and freezing weather, though mushrooms properly covered can survive temperatures to 23° F and still recover in warmer weather. (Note: do not spray logs with water for frost control, particularly if the mushrooms are fairly well-developed.) The fruiting cycle gets shorter and shorter as temperatures increase and spring progresses. Cover the logs immediately after

soaking and stacking with a fruiting blanket and keep it on throughout the fruiting cycle. If you experience frequent rainstorms, we find fruiting blankets will take a fair amount of moisture before they become saturated. Long, rainy stretches require covering the blankets with plastic to shed the water, or else the mushrooms will be wetter than desired and picking them miserable. Wide sheets of clear plastic without holes are well worth the investment in these situations.

Since May is typically the wettest month in the North, you can rely on forced fruiting in the early spring (April) without fear of rainfall stimulating natural fruiting all at once, depleting your log resources for future fruiting. In late spring, fruit the tail end of the cold weather strains but begin to concentrate on wide-range strains that will fruit throughout late spring and early summer.

SUMMER

Fruit the warm weather strains. Plan on only about one week from first soaking to harvest. In mid to late summer, fruit the same logs inoculated with wide-range strains you fruited in late spring/early summer. The goal is to have 6-8 weeks of rest between summer fruitings.

AUTUMN

Begin to fruit the cold weather strains that have formed primordia, and fruit these as long as the weather permits. During the entire growing season, remember to keep an eye on moisture content in all strains for primordia formation. In the north, water liberally the cold weather strains you intend to fruit the next spring. The intention is to form primordia while temperatures are still between 60° and 70° F.

WINTER

In the north, let logs rest through the winter; the primordia will remain dormant until development in the spring. In the South, continue to fruit cold weather strains with the use of protective coverings.

Year-Round Shiitake Cultivation

Certainly any grower who expects to sell his production without anxiously looking for buyers each week and expects a fair price must be able to supply the mushroom all year to his customers. Not only must the mushrooms be shipped on a consistent basis, but as good quality produce.

What follows are the fundamentals a grower should know before embarking on or scaling up to a year-round production facility.

SHELTER

The first thing you will need is a structure. The size structure you will want depends on how many mushrooms you plan on producing. The building can be old or new, but in either case, should be insulated to keep the cost of heating or cooling to a minimum. The economics of conversion must consider all of the following factors if an existing building is going to be converted into a year-round structure or if a new structure is going to be built.

FLOORS

There are two options when choosing a floor, either paved or unpaved. There are advantages to either selection.

Concrete floors are permanent and they can be hosed down to maintain humidity and a clean environment. If you plan on using any wheeled implement to assist in log handling, such as a pallet jack, concrete floors are essential. Their major drawback is cost.

In constructing an unpaved floor, there are a variety of earth materials for use as a flooring option. Gravel is commonly used because of its availability and low cost. The gravel can be hosed down to maintain relative humidity levels. The type of gravel used depends on what is mined locally. Aim to purchase an unwashed material that has a small particle size. Gravel cannot be swept, and trash from bedlogs will accumulate in it. This problem can be somewhat overcome by periodic applications of barn lime which will, in time, form a somewhat hardened surface which can be swept.

INSULATION

In the northern US, buildings must be heavily insulated to minimize heating costs in the winter months. This heavy insulation also serves to slow the warming of buildings in the summer months. Any insulation material used must also have a properly installed vapor barrier. This barrier must be placed between the growing chamber and insulation to prevent decay problems in the building structure.

HEATING AND COOLING SYSTEMS

Due to rising fuel costs, a heating system must be chosen carefully. Most growers heat with wood because spent shiitake logs can be used for fuel and/or they have a good supply of cheap firewood.

Distributing the heat from the burner firebox can be done in a variety of ways. The wood can be used to heat water. This hot water is then distributed through pipes to radiators. Heat from the radiators can be dissipated either via convection or by using a fan to blow the heat around. Hot water can be used as a radiant heat source by embedding hot water lines into a concrete or gravel floor. This system has its advantage in that the heat in the building can be zoned for different

stages of cultivation. The radiant heat also provides uniform ripening on the bed log. This heating system also reduces hot and cold spots like those produced by forced air heat. Undesirable mushroom drying is also minimal because there are no drafts.

Wood fired forced air, natural gas or propane furnaces can also be used as a heating plant. The ducts should be installed low and in a manner as not to blow the heated air directly onto the bed logs. Combustion air must be brought in from the outside to avoid depleting the oxygen levels in the building.

CONDITIONED AIR

Conditioned air also offers a possibility for heating and cooling the building air space. With this system, a suitable length and diameter of pipe or conduit is buried below the frost level to a depth where the soil temperature is constant throughout the year. The intake end of the pipe is located within the building on the floor. The pipe is buried in the shape of a big U extending out from the building to a length determined for the building's volume. The exhaust end is looped back into the building and exhausts at floor level or into a duct system to distribute it. This system will heat or cool the building to the soil temperature. Air entering the system can be humidified by injecting water vapor into the system inlet or outlet.

Another way of warming cool, fresh incoming air is through an "air to air heat exchanger." Outgoing warm, stale air is passed through mixing plenum into which cold outside air is also passing. The warm outgoing air warms the incoming cold air. The air is then distributed throughout the building via ducts.

Swamp coolers are another means of cooling and humidifying the air in a chamber. This system involves the principle of cooling through evaporation. A fabric wall is constructed and continually saturated with water. Air is forced through the fabric with a blower or is pulled through by a blower on the other side of the changer. The water vapor will cool the environment and also raise the humidity.

Summertime cooling of a structure can also be achieved through the use of nighttime cooling. This "highly technical" method involves opening all the building windows at night. Before the sun peaks high over the eastern horizon the following morning, the windows are closed. This method is very cost effective as all it might cost the grower is a little sleep in the morning.

AIRFLOW

One of the by-products of decay is carbon dioxide. Carbon dioxide in sufficient quantities (>2500 ppm) will cause mushrooms to have excessively long stems and/or sticky caps. The excess carbon dioxide must be removed and replaced with oxygen to maintain mushroom production and quality.

There are several systems for fresh air exchange in a mushroom production facility. Two are discussed here.

Buried Pipe System

A buried pipe system will serve a dual purpose: it will draw in fresh air and provide heating and/or cooling depending upon the season. Here is a basic outline of how this system works.

A suitable length and diameter of pipe is buried below the local frost level and to a depth where the soil temperature is consistent throughout the year. The start of the pipe run has risers that protrude above the soil surface to allow for the intake of fresh air. The risers are connected to the buried pipes with a 'T' fitting to allow excessive moisture to drain from the pipe run. The longer the buried run, the more the air has an opportunity to be heated or cooled through conduction and friction. The air passes through the pipe into the building where it enters a mixing box. The mixing box is arranged so that fresh air from the outside can be mixed with inside air to temper it if it is too cold. The air is then pushed from the plenum with a blower into greenhouse bags and distributed throughout the building.

Controlling Humidity

The air entering the greenhouse bags can also be humidified by supplying a water mist where the air exits the plenum. This can be done using an ultrasonic humidifier or similar device. The air can be further recirculated in the building by mounting a window fan near the ceiling so that the fan blades pull the air up towards the ceiling and disperses it in a radial pattern. In this manner the air is pushed along the ceiling and down the walls and drawn back up again.

Other units are also available which draw air directly from the outside environment. These units may then either activate a heating or cooling coil, dependent upon air temperature, and then disperse the air through tubes to the desired location. These units can also be adapted to humidify the air.

The size of the pipes and blowers are dependent upon building volume, desired fresh air exchange rate, and the length of the air tubes. This information is available in the reference section.

SOAKING TANKS

Small operations (<100 pounds per week) can usually get by with non-permanent tanks such as livestock tanks. These tanks are readily available from farm supply stores in a variety of sizes which can be selected to suit your requirements. For instance, a 385 gallon tank will hold about 60 logs with an average diameter of 4 inches.

Livestock tanks are portable, that is, they can be moved from log pile to log pile instead of moving logs from the pile to the tank.

In-ground Tanks

Larger operations may want to consider an in-ground soaking tank. These tanks are generally constructed of poured concrete and built to accommodate a rack system which allows for the efficient handling of a large number of logs. The tank can be placed totally in the ground or half above ground and half below ground. The latter design is safer and will prevent accidental drowning and equipment from taking unscheduled baths! The former design will maintain a cooler water temperature longer due to the buffering capacity of the surrounding ground.

An alternative to a poured tank is the septic vault. These are available from vault producers in a variety of sizes. This type of tank can be either set above ground or buried.

Placing logs into the tank can be achieved through the use of an overhead crane or a tractor lift. If a tractor or skid steer is used to place the logs into the tank, enough overhead clearance must be designed into the building to allow for the reach of the equipment's loader arms.

RACK SYSTEMS

Construction of racks is geared towards the grower's log moving equipment capabilities. The racks should be built so that they can be loaded and unloaded quickly and easily. The rack should be built to accommodate the length of the bed log. Their log capacity must not exceed the lift capacity of the crane or machinery hydraulics.

It is best to avoid a racking system that permanently mounts the log into the rack. This will hinder the removal of unproductive logs from the system with the result being that tank and fruiting space is dedicated to poor productivity.

Fruiting Racks

After the logs are soaked they need to be placed into a fruiting position. Logs can be stacked in lean-to piles for this if space is not at a premium. However, most growers do not have the luxury of too much space, so fruiting racks are employed.

A commonly used fruiting rack is the pick-through rack. This system utilizes space very efficiently. The racks can be constructed of iron reinforcing rods or 2 x 4's. The racks serve to hold two elevated crosspieces which support the logs. The crosspieces are supported by the racks on one end and by a 2 x 4 attached to the wall. The fruiting logs are then "picked through" from one end to the other.

Horizontal racks can also be used to take advantage of the vertical space in a fruiting room that otherwise is not used. When using this type of rack system, the fruiting environment must be well maintained to prevent drying of the upper logs and their mushroom crop.

REFERENCES

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QUESTION & ANSWER SESSION: JOE KRAWCZYK

Q: *Are forestry stands being managed for sustainable yield?*

A: Our logs are being cut from timber improvement stands. We promote timber stand improvement and future productivity of the forest.

Q: *What are your costs per log?*

A: "Two Old Polish Guys Lumbering Co., Inc." cut our logs. They cut three thousand logs and we paid $70 per shiitake cord measuring 4' high by 8' long and 40" wide.